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The Water Bureau of the Helsinki District
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LITERATURE

1. INTRODUCTION

Two fish farms operate in the sea off Sipoo. The Melander Fish Farm lies in Storsundet north of the isle of Soderkullalandet. A basin 11 m deep runs east and west in the strait, but the rest of the nearby areas have a depth < 10 m. The estimated annual production of the Melander Fish Farm is 7 000 kg/a, while the estimated fresh feed consumption is 30 000 - 35 000 kg/a. Phosphorus load has been calculated to be about 2.9 kg P/d. An advance notice submitted by the Fish Farm was approved by the Central Water Board in 1983.

The Granqvist Fish Farm lies in a strait between Moholmen and Komsalo (islands). The depth of the strait ranges from 7 to 14 m. The water changes moderately well. It has been estimated that the annual production of the Farm is 25 000 kg/a and that its feed consumption is 45 000 kg/a dry feed. The Water Board granted an operating licence to the Farm in 1982.

The aim of the zoobenthos study is to examine the quality and the pollution degree of the bottom in the study area and the effect of fish farming on these, considering also other loads received by the area.

2. OTHER LOADS RECEIVED BY THE AREA AND WATER QUALITY

In addition to loads originating in the fish farms, the area receives wastewaters from the Bay of Sipoo, where the Soderkulla wastewater treatment plant is situated. Furthermore, the Bay of Sipoo receives Sipoo River, which is a discharge place for the Nikkila wastewater treatment plant. In 1982, loads from the wastewater treatment plants amounted to : BOD_7 32 kg/d, P 1.6 kg/d, and N 50 kg/d. The load of the drainage area of Sipoo River and the Bay of Sipoo was estimated at P about 38 kg/d and N about 708 kg/d.

It has been difficult to measure, with regular water analyses, the eutrophication of waters caused by the fish farms. According to the water studies of the Helsinki Water District and Suunnittelukeskus Oy (Planning Center Co), a rise in nutrient contents and bacterial counts has been observed only in the immediate neighborhood of the fish farms. However, nutrient contents have increased only slightly, and the bacterial counts observed indicate no obvious hygienic shortcomings. In summer 1984, 0 - 6 fecal streptococci per 100 mL were found in the immediate vicinity of the fish farms. Phosphorus contents of 26 - 40 µg/L were found in the vicinity of the farms, while the phosphorus content of the open water off Sipoo (Sipoonselka) simultaneously varied from 24 to 32 µg/L. Nitrogen contents were 370 - 500 µg/L in the farm areas and 310 - 410 g/L at the control station. Oxygen contents were generally high in shallow areas and lower in basins. According to the 1983 - 1984 results, the lowest oxygen content was measured in a basin near Trano in Kalkbruksfjarden : 3.8 mg O_2/L. The low oxygen content in the basin is not caused by fish farming, as e.g. in summer 1975, a content of 2.8 mg O_2/L was measured in the basin. No oxygen failures have been observed in the whole area during the study periods. Salinity above bottom sediment varied in the whole area between 5.23 and 5.71 % in 1983.

3. METHODS

The benthic fauna was sampled from Sept. 18 to Sept. 20 1984. Eight observation stations were situated in the neighborhood of the Melander Farm and 12 in the neighborhood of the Granqvist Farm (maps 1 - 2). The samples were taken linearly on two sides of the farms in the basin parts. Also, there were two control stations east of Moholmen. The samples were collected by means of an Ekman-Birge -type bottom sampler with a bottom area of 289 cm^2. One sample (= one observation station) consisted of three separate takes. The samples were screened with a 0.6 mm screen. The animals were collected from the screen alive latest the next day and preserved in 70 % alcohol. A biomass determination was carried out in about 1 ½ months, when the animals were weighed after drying on adsorbent paper, and the species were determined. The Macoma were weighed with their shells open, and the length of the shell was measured with a precision of 0.5 mm.

Kartta 1. Havaintoasemat Melanderin kalankasvatuslaitoksen ympäristössä

Map 1 : Observation stations in the vicinity of the Melander Fish Farm

Mittakaava 1:20 000 **SCALE**

● HAVAINTOASEMA **OBSERVATION STATION**

▲ KALANKASVATUSLAITOS **FISH FARM**

Map 2 : Observation stations in the vicinity of the Granqvist Fish Farm

Kartta 2. Havaintoasemat Granqvistin kalankasvatuslaitoksen ympäristössä

4. RESULTS

4.1 Environment of the Melander Fish Farm

4.1.1 Quality of bottom

The bottom sediment of all observation stations consisted of almost the same soft, dark-grey mud. There was no smell of sulphide, but the mud was clearly darker in the vicinity of the farm and it had sulphide streaks in it. The bottom became slightly harder east of the fish farm, and the mud was admixed with clay especially at the Raagholmsfjarden observation station. The soft bottom of the area was well suited for the Ekman sampler, and there were no rejected samples.

4.1.2 Zoobenthic species

The benthic fauna of the area was fairly one-sided. Oligochaeta and larvae of Chironomidae dominated clearly. Crustacea and Macoma baltica were almost absent. The number of species ranged from 3 to 6.

The species represented a fauna typical of a polluted mud bottom. The dominant Oligochaeta are very common in the shallow, mud-bottomed bays of the environment of Helsinki (i.a. Laakso 1965, Varmo 1984). Among the Oligochaeta, the most common and abundant was Potamothrix hammoniensis, which tolerates fairly well different salt and oxygen contents (Bagge & Ilus 1973). The species is typical of somewhat polluted, shallow inner bays with occasionally occurring low salinity.

Almost all observation stations had larvae of Chironomidae, of which clearly the most common was the Chironomus plumosus group. The group occurs abundantly in polluted areas (i.a. Tulkki 1967, Bagge & Ilus 1973) and is practically the only animal group occurring on severely polluted bottoms. No species of the Chironomidae larvae have been found in a zone representing unaffected bottoms off Helsinki (Varmo & Skog 1980, Varmo 1984). Besides larvae, the samples contained a number of pupal stages.

It was remarkable that Macoma baltica was almost fully absent in the study area. It favors a harder mud bottom, and thus, the sediment in the area is obviously too soft to allow the younger stages of Macoma to thrive. As the salt content constitutes no obstruction to its thriving in the area, and as predation does not take place in areas as shallow as this, the contamination of the sea floor must be the most essential reason for the disappearance of Macoma baltica. Also, the absence of large Macoma (and empty shells) indicates that M. baltica disappeared from the area several years ago.

There are few other species around Storsundet. Only one species representative of unaffected waters was found, which was a Pontoporeia affinis on a harder bottom in Raagholmsfjarden (Table 1).

4.1.3 Zoobenthic densities and biomasses

Individual densities in Storsundet and the observation stations west of it varied between 1 415 and 2 255 ind./m^2, while the mean for the entire area was 1 595 ind./m^2. The lowest density, 634 ind./m^2, was encountered at the Raagholmsfjarden observation station (8). Oligochaeta were responsible for more than 90 % of the density. The result is similar to the individual densities of the Oligochaeta group in the contaminated zones off Helsinki (Varmo 1984).

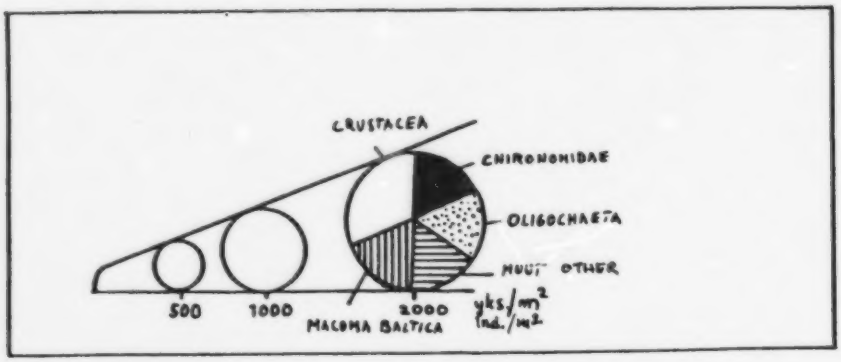
The individual densities of the Chironomidae larvae were clearly smaller than those of Oligochaeta, varying from 46 to 208 ind./m^2 ($\bar{x}$ 97 ind./m^2). The largest occurrences of the larvae were found immediately west of the fish farm.

The total biomasses of the benthic fauna varied between 1.17 and 5.98 g/m^2, with the exception of Station 8. Occurrence of M. baltica raised the total biomass at Station 8 to 39.32 g/m^2. The mean biomass of Oligochaeta was 0.94 g/m^2 and that of Chironomidae larvae 2.12 g/m^2. In the absence of Macoma, the total biomasses stayed very low. In general, the total biomass of the shallow and soft-bottomed areas off Helsinki has been only a few grams per m^2 (Varmo 1984) (Table 1, Figures 1 - 2).

Table 1: Benthic fauna in the environment of the Melander Fish Farm

Taulukko 1. Pohjaeläimistö Melanderin kalankasvatuslaitoksen ympäristössä

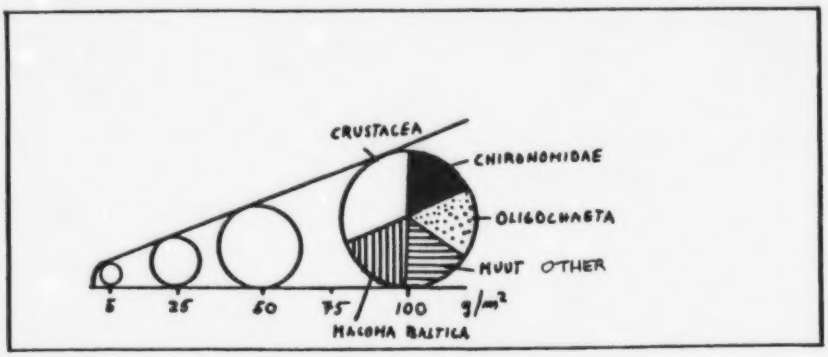
asema / station		1		2		3		4		5		6		7		8	
syvyys m / depth, m		10		10		10		11.5		10.5		9.5		10		7.5	
tiheys/biomassa / density/bio.		kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²
OLIGOCHAETA	MIST	1369	1.16	1553	0.86	2116	1.39	1254	0.82	1840	1.17	1829	0.86	1438	0.94	564	0.32
Potamothrix hammoniensis		1300		1553	0.86	2116	1.39	1254	0.82	1794		1794		1438	0.94	564	0.32
Tubifex costatus										46							
Psammoryctides barbatus																	
Tubificidae		69										35					
POLYCHAETA																	
Hereis diversicolor																	
TRICHOPTERA				12	0.77							41	0.04				
CRUSTACEA						11	0.15									12	0.03
Pontoporeia affinis																	
Gammarus sp.																12	0.03
Mysis relicta																	
Mesidotea entomon						12	0.15										
LAMELLIBRANCHIATA																	
Macoma baltica																58	39.32
CHIRONOMIDAE (DIPTERA)		46	1.71	69	1.30	127	2.95	208	5.16	58	0.84	93	0.29	81	2.81		
Chironomus plumosus r		46	1.71	69	1.30	92	2.36	196	4.33	58	0.84	46	0.15	69	2.21		
Chironomus anthracinus r																	
Chironomidae																	
Chironomidae kotelo						12	0.57	12	0.83			12	0.09	12	0.40		
Procladius sp.												35	0.05				
Cricotopus (?)						23	0.02										
YHTEENSÄ / Total		1415	2.87	1634	2.93	2255	4.49	1462	5.98	1910	2.38	1934	1.17	1519	3.35	634	39.67
lajeja / species		3		3		5		3		6		6		3		3	
liikaantuminen / pollution		polluted		polluted		polluted		polluted		polluted		polluted		polluted		slightly polluted	
pohjan laatu / bottom quality		liikaantunut		liikaantunut		liikaantunut		liikaantunut		liikaantunut		liikaantunut		liikaantunut		liikaantunut	
		lieju	mud	lieju	mud	lieju	mud	lieju	mud	lieju	mud	lieju	mud	lieju.savi	mud, clay	lieju. savi	mud, clay



Scale :
Mittakaava 1:20 000

Figure 1: Individual densities of benthic fauna in the environment of the Melander Fish Farm

Kuva 1. Pohjaeläinten yksilötiheydet Melanderin kalankasvatuslaitoksen ympäristössä



Scale :
Mittakaava 1:20 000

Rågholms-
fjärden

Gumbo

Takvedaholmen

laitos
Fish farm

Söderkullalandet

Opanholmen

Figure 2 : Benthic fauna biomasses in the environment of the Melander Fish Farm

Kuva 2. Pohjaeläinten biomassat Melanderin kalankasvatuslaitoksen ympäristössä

4.1.4 Degree of pollution of the bottom

In zoobenthic studies, the bottom is usually divided into several zones of pollution. The basis of the present classification is discussed in greater detail e.g. by Varmo & Skog (1980) and Varmo (1984) in their zoobenthic reports concerning the seas off Helsinki and Espoo .

Zone I : unaffected bottom
II : almost unaffected bottom
III : slightly polluted bottom
IV : polluted bottom
V : severely polluted bottom

Observation stations 1 - 7 represent a polluted bottom in the study area. This is indicated by i.a. a small number of species, absence of indicators for unaffected bottom, abundant occurrence of the Chironomus plumosus group, absence of Macoma baltica, and total biomasses below the normal. Station 8 can be considered to lie on the boundary between a polluted and a slightly polluted zone. A less polluted bottom quality was reflected i.a. by the absence of the Chironomus plumosus group, smaller number of Oligochaeta, and occurrence of Macoma baltica. However, indicator species for an unaffected bottom were absent.

The one-sided species composition and absence of Macoma baltica indicate that the bottom has become polluted several years ago. If the polluting effect is assumed to be caused by the fish farm alone (2 years of operation), the species composition should at this stage still be more polymorphic at least towards the borders of the area. The eutrophication of the bottom sediment of the fish farm is at the moment most obviously reflected by the increasing Chironomus plumosus group at observation stations 3 - 4. At the other observation stations, the effect of the fish farm has hardly made the bottom quality any worse. The pollution is assumed to a large extent to be restricted to the elongated basin in the area, because the observation station in Raagholmsfjarden outside the basin clearly represented a cleaner bottom.

4.2 Environment of the Granqvist Fish Farm

4.2.1 Quality of bottom

At the observation stations, the bottom consisted mainly of mud and clay. Besides, there was some fine silt in the bottom sediment at stations north of Komsalo. The strait between Bargarholmen and Skutholmen had some gravel besides mud and clay, and Station 9 had sand besides mud. North of the fish farm, the bottom was clearly harder, and the sediment contained more clay. Some stations still had some plant remnants.

4.2.2 Zoobenthic species

The most common benthic fauna groups were Oligochaeta, Chironomidae, and Macoma baltica. There were some Crustacea species at the outer stations. The species numbered 2 - 4 in the zone < 10 m deep and 5 - 8 in the zone ≥ 10 m deep.

The most common species was Macoma baltica, which occurred at all observation stations. Macoma is a common species on shallow mud bottoms, and it tolerates well some degree of pollution as well as variations in salinity (i.a. Koli 1961, Laakso 1965, Sarkka 1969).

Almost all observation stations had also Potamothrix hammoniensis, and Chironomus plumosus groups. Both of these favor mud bottoms and survive in polluted areas. Among the larvae of Chironomidae, the genus Procladius occurred commonly, except at the deepest observation stations. Procladius has been regarded as a species characteristic of slightly polluted bottoms (Jumppanen 1976, Sarkka 1979) or as indifferent (Leppakoski 1975).
A few observation stations had a Chironomus anthracinus group, which thrives in less polluted areas than the C. plumosis group. Nereis diversicoloria, an important pollution indicator, was encountered at one observation station only.

Pontoporeia affinis and Tubifex costatus were common at the deepest observation stations. These species require a higher salinity and as a rule avoid polluted areas. Pollution indicators were the most common species in the study area. Species indicating a more unaffected bottom increased at the more remote and deeper stations (Table 2).

Table 2 : Benthic fauna in the environment of the Granqvist Fish Farm

Taulukko 2. Pohjaeläimistö Granqvistin kalankasvatuslaitoksen ympäristössä

asema Station	1		2		3		4		5		6		7		8		9		10		11		12	
syvyys m depth m	7.0		6.0		6.5		7.5		10.0		6.5		12.0		13.5		13.5		17.0		18.0		14.5	
tiheys/biomassa dens./biom.	ind. kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	kpl/m²	g/m²	ind. kpl/m²	g/m²
OLIGOCHAETA	46	0.04			495	0.45	23	0.02	644	0.64	196	0.18	1116	0.46	1185	0.98	1518	0.79	667	1.13	598	0.68	1323	1.21
Potamothrix hammoniensis					495	0.45	23	0.02	598		196	0.18	1047		1024		391		299		575		1254	
Tubifex costatus													69		161		1034		368		23		69	
Psammoryctides barbatus									46								58							
Tubificidae																	35							
POLYCHAETA																								
Nereis diversicolor			12	0.95																				
TRICHOPTERA																								
CRUSTACEA					12	0.07			23	0.08	12	0.03	12	0.15	58	0.25	242	37.72	104	0.60	59	9.38	93	0.58
Pontoporeia affinis					12	0.07			23	0.08	12	0.03	12	0.15	58	0.25	230	1.04	104	0.60	35	0.16	81	0.33
Gammarus sp.																								
Mysis relicta																					12	0.31	12	0.25
Mesidotea entomon																	12	36.68			12	8.91		
LAMELLIBRANCHIATA																								
Macoma baltica	150	94.07	472	109.76	46	8.65	138	12.16	219	71.50	69	20.06	69	25.46	58	25.90	150	46.55	115	48.90	104	34.06	58	31.53
CHIRODOMIDAE (INSECTA)	311	1.46	150	0.48	105	0.86			633	0.89	312	2.22	1231	6.23	219	0.60	230	0.50	35	0.26	35	0.53	46	1.38
Chironomus plumosus gr.	288	1.45	115	0.42	81	0.82			598	0.61	242	1.96	1231	6.23	184	0.55	230	0.50			23	0.52	46	1.38
Chironomus anthracinus gr.					12	0.02									12	0.005								
Chironomidae																			23	0.04	12	0.01		
Chironomidae kotelo pupae											12	0.16							12	0.22				
Procladius sp.	23	0.01	35	0.06	12	0.02			35	0.28	58	0.10			23	0.04								
Cricotopus (?)																								
YHTEENSÄ Total	507	95.57	634	111.19	658	10.03	161	12.18	1519	73.11	589	22.49	2428	32.30	1520	27.73	2140	85.56	921	50.89	796	44.65	1520	34.70
lajeja spp.																	polluted/ slightly poll.							
likaantuminen pollution	4 polluted		4 polluted		6 polluted		2 slightly poll.		6 polluted		6 polluted		3 polluted		7 polluted		likaantunut/ lievl.likaant.		5 slightly poll.		8 slightly poll.		8 slightly poll.	
pohjan laatu bottom quality	likaantunut		likaantunut		likaantunut		lievl.likaant.		likaantunut		likaantunut		likaantunut		likaantunut		likaantunut/ lievl.likaant.		lievl.likaant.		lievl.likaant.		lievl.likaant.	
	savi, lieju, hiesu		savi, sora		savi, lieju, hiesu		savi, lieju, hiesu		savi, sora, lieju		lieju, savi		lieju		lieju		lieju, hiekka		lieju		lieju		lieju	
	clay, mud, fine silt		clay, gravel		clay, mud, fine silt		clay, mud, fine silt		clay, gravel, mud		mud, clay		mud		mud		mud, sand		mud		mud		mud	

4.2.3 Zoobenthic densities and biomasses

Individial densities in the area showed a variation of 161 - 2 428 ind./m^2. The mean was 1 116 ind./m^2. The greatest densities occurred in the immediate surrounding of the fish farm and at the observation stations SE of it.

At observation stations north of the fish farm, Macoma baltica's share of the total density was greatest at stations 2 and 4. The Chironomidae group represented the greatest share north of Bargarholmen (1), while the Oligochaeta group dominated west of Bargarholmen (3). In the immediate surrounding of the fish farm (stations 5 - 7) , a group of Chironomidae larvae dominated with an individual density that was 42 - 53 % of the total individual density. Oligochaeta were obviously the most abundant at Kalkbruksfjarden (stations 8 - 12) , representing 71 - 87 % of the total individual density.

The total biomasses showed a variation of 10.03 - 111.19 g/m^2, with a mean of 50.03 g/m^2. Macoma baltica mostly constituted more than 90 % of the total biomass. Crustaceans had a 21 - 44 % share of the total biomasses at deeper observation stations, and the larvae of Chironomidae had a 19 % share at station 7. The biomasses of other groups of the benthic fauna were small. Macoma baltica had a mean biomass of 44.05 g/m^2, the Crustacea group 5.42 g/m^2, the Chironomidae group 1.40 g/m^2 and the Oligochaeta group 0.59 g/m^2.

The individual densities and biomasses of different animal groups were at most observation stations of about the same magnitude as in the polluted bottoms off Helsinki (Varmo 1984). At the outer stations, the quality of the bottom was somewhat better (Table 2, Figs. 3 - 4).

4.2.4 Macoma baltica : Distribution by size classes

Macoma populations were small at all observation stations. There were only a few Macoma at many stations so that size distribution could not be studied sufficiently. Also, individuals < 1 mm are not well represented in the results, due to the mesh size (0.6 mm) of the screen.

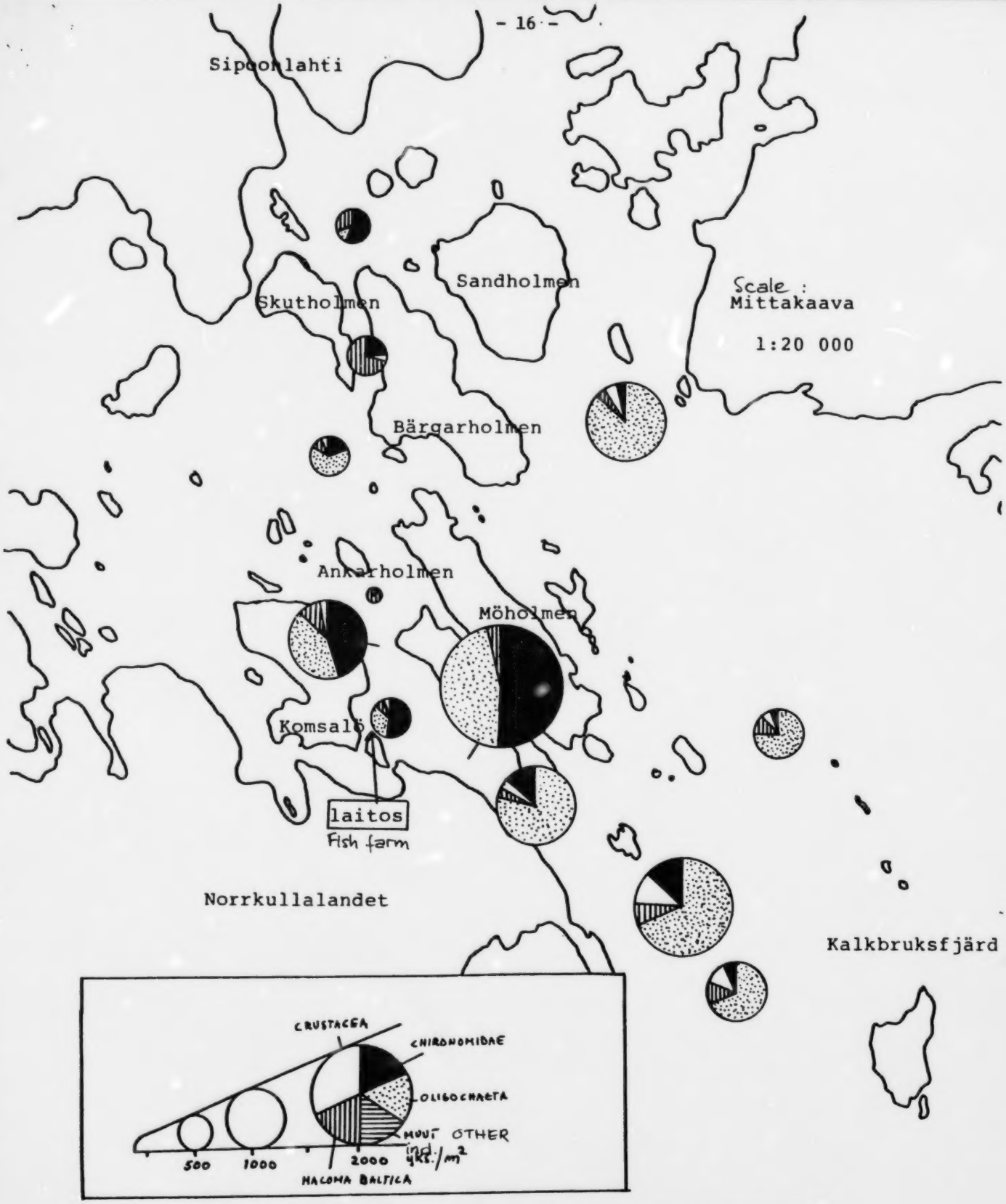


Fig. 3 Individual densities of benthic fauna in the environment of the Granqvist Fish Farm

Kuva 3. Pohjaeläinten yksilötiheydet Granqvistin kalankasvatuslaitoksen ympäristössä

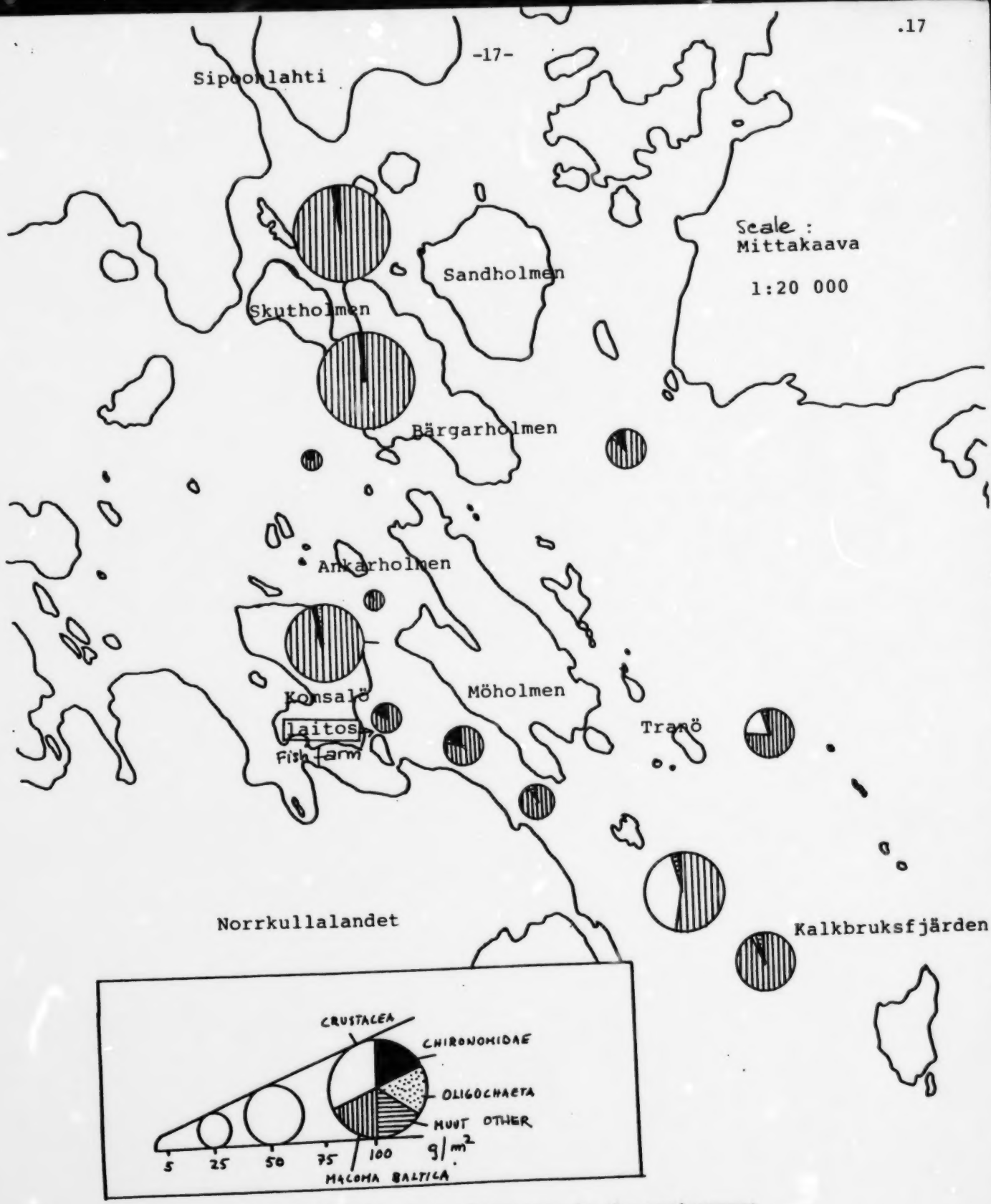


Fig. 4 Benthic fauna biomasses in the environment of the Granqvist Fish Farm

Kuva 4. Pohjaeläinten biomassat Granqvistin kalankasvatuslaitoksen ympäristössä

When Macoma occurs abundantly on soft bottoms, its size distribution is balanced when the population consists mostly of small individuals (Hakkila 1983). Young age classes have been observed to be abundant especially in the slightly polluted zone.

In the area studied, young age classes occurred south of Ankarholmen (stations 4 - 5) and at Station 10 in Kalkbruksfjarden. The conditions at observation station 4 have changed so that they favor multiplication of Macoma, obviously because of the increase in nutrients. Old age classes were practically absent in the area. All age classes of Macoma occurred (sparsely) at Station 5 inspite of an obvious pollution of its bottom, and Macoma is still capable of multiplying in this area.

The different age classes of Macoma populations inhabiting the basins have been observed to show, even in unaffected places, age class structures deviating from the normal, because i.a. of nutritional conditions and predation (Molsa & Hakkila 1981). Some age classes were absent at Station 10 in Kalkbruksfjarden evidently because predation and poor nutrition impaired the survival of the young. However, Macoma are increasing in this area, while in the basin (11) near Trano all young age classes are absent.

The different age groups were best represented in the strait between Skutholmen and Bargarholmen (2), which also contained the highest individual Macoma density of the study area. At observation stations 1, 3, 6 - 9, and 12, old individuals dominated (Figs. 5 - 7), as pollution obviously did not allow the young age classes to survive.

4.2.5. Degree of pollution of the bottom

The bottom of stations 1 - 3 in the area in front of the Bay of Sipoo and extending to the west of Bargarholmen was polluted. The poorest bottom conditions were found off the Bay of Sipoo (1), while the quality somewhat improved towards Station 3. A typical pollution-indicator was the Chironomus plumosus group, which dominated at Station 1 and showed some decline towards the south.

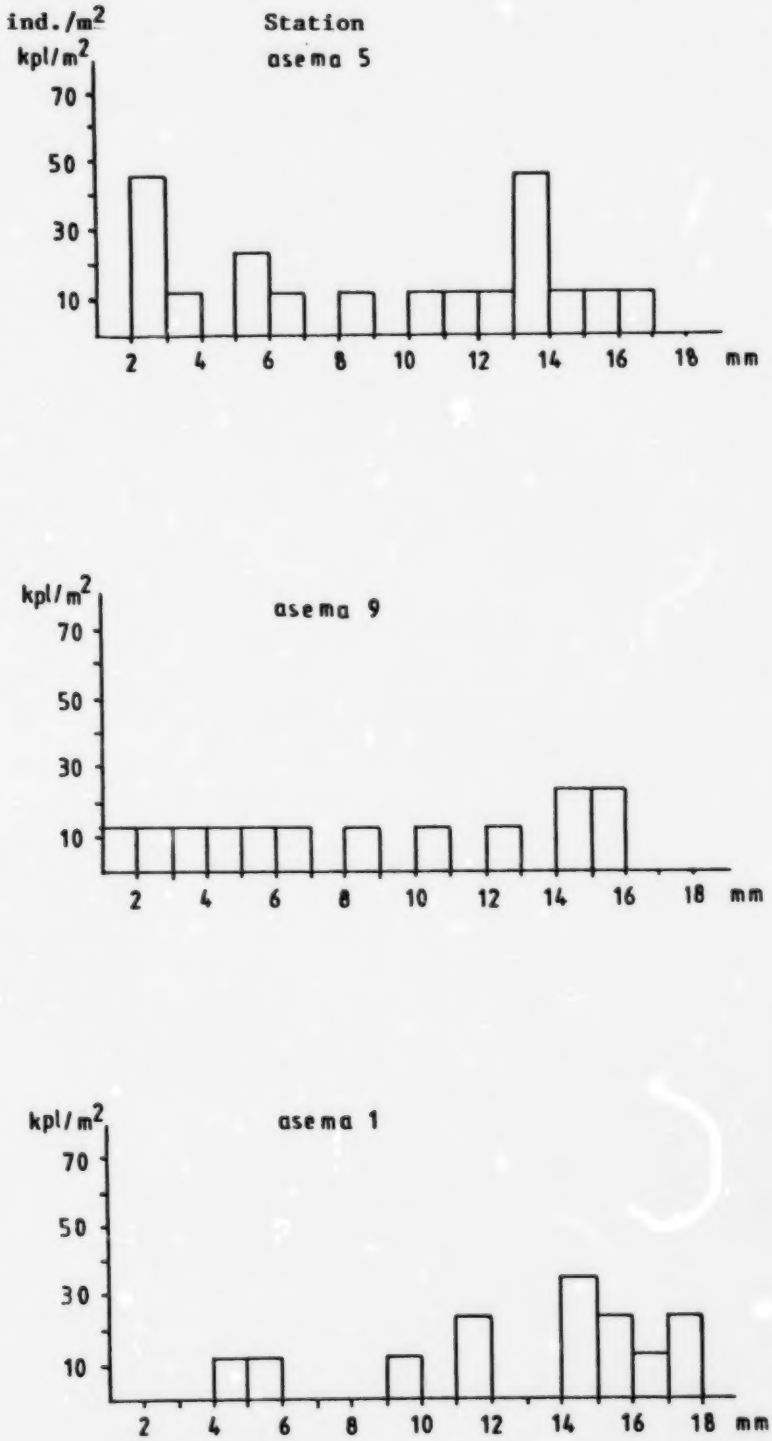


Fig. 5 Size class distribution of Macoma baltica at stations 1, 5 and 9 in the environment of the Granqvist Fish Farm

Kuva 5. Macoma baltican kokoluokkajakauma Granqvistin kalankasvatuslaitoksen ympäristössä asemilla 1, 5 ja 9

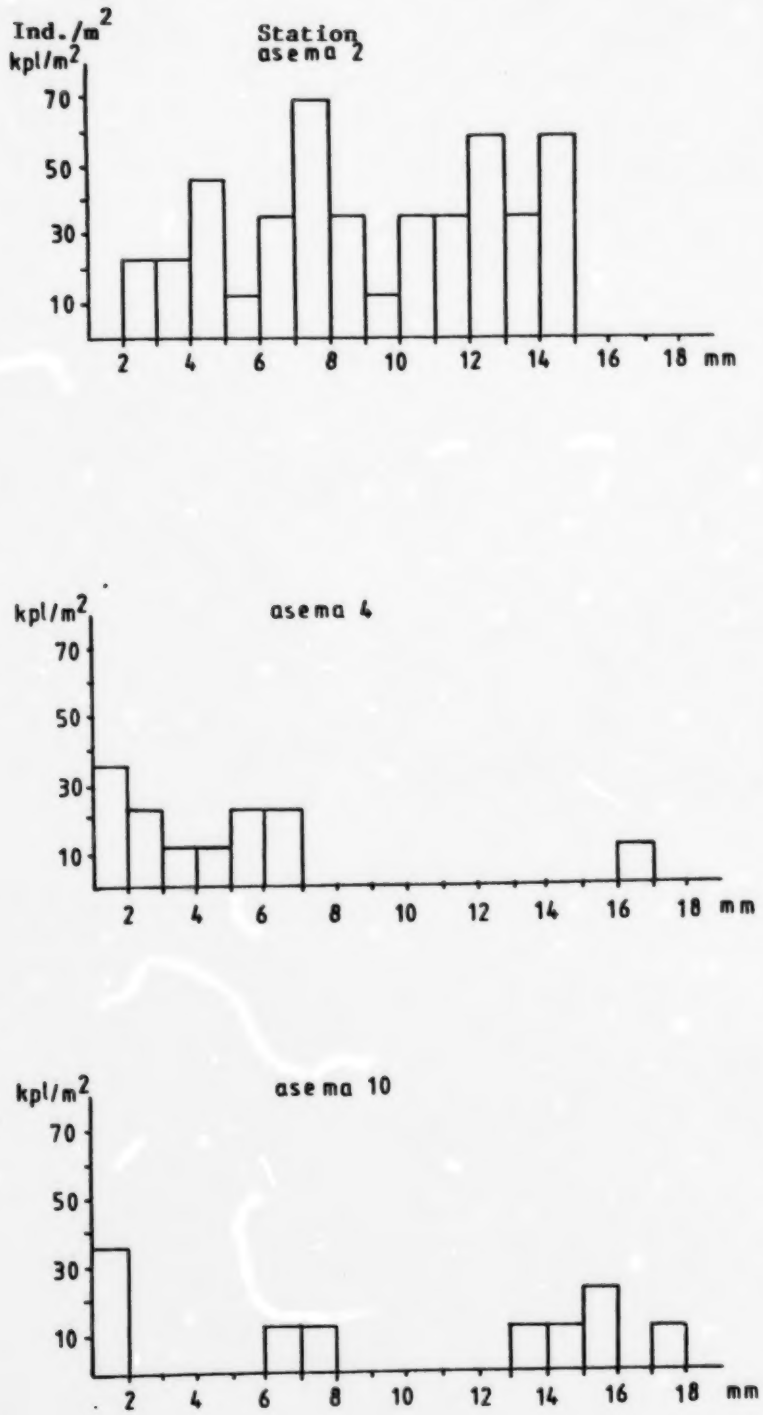


Fig. 6 Size class distribution of Macoma baltica at stations 2, 4 and 10 in the environment of the Granqvist Fish Farm

Kuva 6. Macoma baltican kokoluokkajakauma Granqvistin kalankasvatuslaitoksen ympäristössä asemilla 2, 4 ja 10

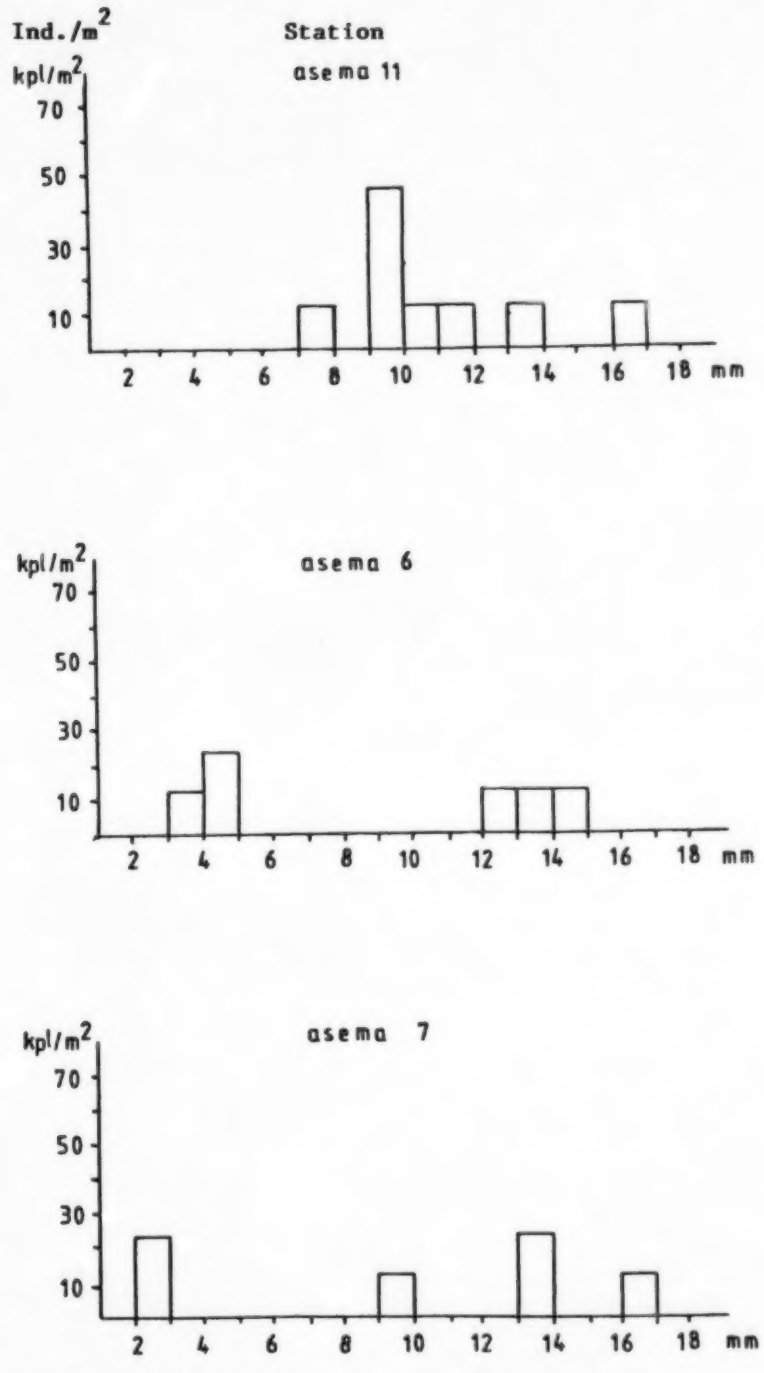


Fig. 7 Size class distribution of Macoma baltica at stations 6, 7 and 11 in the environment of the Granqvist Fish Farm

Kuva 7. Macoma baltican kokoluokkajakauma Granqvistin kalankasvatuslaitoksen ympäristössä asemilla 6, 7 ja 11

Only Macoma baltica and Potamothrix hammoniensis occurred south of Ankarholmen (2). These species reflect a slight eutrophication. As larvae of Chironomidae and indicators of an unaffected bottom were completely absent, the bottom can be considered slightly polluted.

The immediate vicinity of the fish farm and the entire strait between Komsalo and Moholmen (stations 5 - 8) belonged to a zone with a polluted bottom. Bottom fauna groups and species benefitting from pollution dominated in the area. However, Pontoporeia affinis, which avoids pollution, was encountered in small numbers at all stations next to the fish farm, which most probably reflects the recency of the polluting effect. This means that the bottom is becoming more polluted, and the species will probably disappear from the area in the future. The most severe pollution was found at Station 7 SE of the farm, where the Chironomus plumosus group dominated. The polluting effect of fish farming was most clearly seen towards southeast, largely because the basin that starts in front of the farm and becomes increasingly deeper towards the southeast.

At Station 9, further out in Kalkbruksfjarden, the state of the bottom was between polluted and slightly polluted. Oligochaeta and the Chironomus plumosus group continued to be abundant, but the area had a moderate number of Pontoporeia affinis as well. The eutrophication effect of fish farming on the bottom can be regarded as extending to Station 9, while Station 10 already represented a more unaffected bottom.

The bottom of control stations 11 and 12 was slightly polluted. Some species characteristic of deep water occurred, but their densities and biomasses were small. Species favoring pollution were common at these stations. At Station 12, the state of the bottom was somewhat poorer, obviously because of a load from the shore and the Bay of Sipoo. The general eutrophication of the marine areas also promotes the eutrophication of the bottom in the entire study area.

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5. SUMMARY

A zoobenthic investigation of the marine areas off Sipoo was carried out 18 - 20.09.1984 to investigate the effect of fish farming on the bottom sediments of the areas. Samples were collected with a bottom sampler of the type Ekman-Birge. There were 20 observation stations.

The results showed that the whole area was polluted or slightly polluted.

The 3 km long basin passing in front of the Melander Fish Farm was polluted in its entirety. The benthic fauna consisted almost exclusively of Potamothrix hammoniensis and the larvae of the Chironomus plumosus group. The individual densities and biomasses of the fauna were clearly smaller that normal. The one-sided species composition and the complete absence of Macoma baltica indicated that the bottom had been polluted already before the fish farming was started in the area. The pollution may be the result of a longterm development based on the nutrient load brought by the rivers and drainage ditches of the shore and on other loads from the scattered and vacation housing. The effect of fish farming was most clearly indicated by an increase in the larvae of the Chironomus plumosus group at stations 3 and 4 west of the fish farm. The boundary of the polluted area is most probably in the basin, because at the shallower station in Raagholmsfjarden the bottom is already cleaner.

The effect of the Granqvist Fish Farm on the eutrophication of the bottom could be seen in the entire strait between Komsalo and Moholmen (stations 5 - 8). The species most common in the area were Potamothrix hammoniensis, the Chironomus plumosus group, and Macoma baltica. The individual densities and biomasses of the animals and the species composition indicated that the bottom was polluted. The most obviously polluted area was Station 7 SE of the farm, from where the pollution gradually declined towards Station 9 in SE. Observation station 9 in Kalbruksfjarden can be considered at present the extreme SE boundary of the area where the effect of the fish farming can be clearly demonstrated. North of the fish farm, this boundary lies between observation stations 4 and 5 south of Ankarholm. The NW - SE length of the area of observable influence is about 1.8 km.

The pollution-promoting effect of the load originating on the shore and in the Bay of Sipoo was clearly seen in the surroundings of Bargarholmen (stations 1 - 3). The most abundant occurrences in the area were those of the Chironomus plumosus group, Macoma baltica, and Potamothrix hammoniensis. Pollution was most obvious in front of the Bay of Sipoo (1), and it declined gradually towards Raagholmsfjarden (3). Roughly speaking, the direct effect on the bottom of loads originating on the shore and the Bay of Sipoo could be described to extend to the line Ankarholmen - Norrkulla - Kalkstrand. Besides, the entire study area is probably influenced by nutrients coming from the shore and increasing the quantity of plant plankton and thus also the nutrient contents of the bottom (sinking algae).

The basins of Kalkbruksfjarden (stations 10 - 12) were slightly polluted. Station 12 was still under the effect of a load coming from the shore, but otherwise, the pollution was probably caused by an increase in the general eutrophic level of the whole coastal area.

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